Notes on Completion: Please refer to the appropriate NIA Governance Document to assist in the completion of this form. The full completed submission should not exceed 6 pages in total.

NIA Project Registration and PEA Document

Date of Submission

Sep 2024

Project Reference Number

NIA_NGT0244

Project Registration

Project Title

NTS Materials Pipeline Assessment

Project Reference Number

NIA_NGT0244

Project Licensee(s)

National Gas Transmission PLC

Project Start

September 2024

Project Duration

0 years and 5 months

Nominated Project Contact(s)

Robert Best, box.GT.innovation@nationalgas.com

Project Budget

£213,333.00

Summary

Existing hydrogen transmission codes (ASME B31.12, IGEM TD/1 Supp. 2) are applicable to any blend regardless of %H2. These codes require fracture and fatigue assessments on the pipeline to enable operation above 0.5 Design Factor. Indicative pipeline assessments undertaken in the NTS Materials Testing to Enable Hydrogen Injection in High Pressure Pipelines NIA project suggested that many National Transmission System (NTS) pipelines would require reductions of pressure from their current MOPs and/or changes in operational conditions (e.g. reduced pressure cycling) to pass these assessments.

This project will undertake assessments (fracture and fatigue) across the entire NTS to determine the potential impact of hydrogen on pipeline operation. With the results informing the 2% blend safety case submission and Project Unite and Project Union.

Nominated Contact Email Address(es)

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Problem Being Solved

- Existing hydrogen transmission codes (ASME B31.12, IGEM TD/1 Supp. 2) are applicable to any blend regardless of %H2.
- The codes require fracture and fatigue assessments on the pipeline to enable operation above 0.5 Design Factor.
- Indicative pipeline assessments undertaken by DNV in the NTS Materials Testing to Enable Hydrogen Injection in High Pressure Pipelines NIA project suggested that many National Transmission System (NTS) pipelines would require reductions of pressure from their current MOPs and/or changes in operational conditions (e.g. reduced pressure cycling) to pass these assessments.

- The implications of these required changes across the entire NTS need to be understood to inform decisions on Project Unite and Project Union.

Method(s)

This project will comprise work packages to gather the required data for the assessments undertake the assessments and then understand the impact of the assessments for with regards network operation. The proposed project structure is shown below:

WP1 Data Collection and Processing

- Information Gathering
- Synergi Pipeline Data Upload and Processing

WP2 Fracture Mechanics Analysis

- The output from these calculations will be presented in terms of the following,
- The required fracture toughness for a specified maximum operating pressure.
- The maximum allowable maximum operating pressure for a pipeline for a specified value of fracture toughness.
- The main tasks required for Work Package 2 will be as follows:
- Step 1 – Undertake a rainflow cycle counting process for the pipeline pressure monitoring data.
- Step 2 – Fatigue crack growth analysis.
- Step 3 – Fracture analysis

WP3 Network Modelling

- DNV will build steady state hydraulic models of the network in our Synergi Gas software.
- The models would form the basis for understanding how the proposed operational changes might impact the network. An initial baseline model (or models) will be built to show the “as is” situation. From there, scenarios would be run exploring the effects of these operational changes and how key parameters such as pressure and velocity might be changed.
- The final output would be a report detailing how and where changes to the network might be expected.

Measurement Quality Statement

The measurement approach used to meet Data Quality objectives will be through the identification of high calibre project partners who are experts in their given field. In this instance the project will be limited to a desktop assessment of pipelines.

Data Quality Statement

The project will ensure that data used is of sufficient quality to deliver project objectives. The relevant data and background information will be stored for future access within the National Gas Transmission Innovation SharePoint site.

Scope

The National Transmission System (NTS) in the UK offers a resilience to the UK's varying energy demand and supply. It enables suppliers to input gas at one location in the country and transport it to consumers via the distribution networks whilst simultaneously acting as a storage system to ensure there is energy available even on the coldest winters day. The NTS currently transports natural gas which on combustion produces carbon dioxide plus other greenhouse gases which contribute to climate change. The UK has set an ambitious target of eliminating net carbon emissions by 2050 and a wide range of green technologies are required to reach this goal.

A key technology in this transition is hydrogen as an alternative for carbon fuels in heat, transport, and industrial uses. Transporting hydrogen across the UK and connecting renewable energy producers to customers is an opportunity for the NTS and a potential way to extend the life of assets already paid for by UK consumers. However, the NTS was not designed to transport hydrogen and learning needs to be developed on the capability of these assets in this new use case.

The assessments carried out in this project will generate key knowledge on the capability of the NTS to transport hydrogen thereby supporting the overall safety case whilst enabling optimisation of network operations.

The project scope is summarised below:

In Scope

- All NTS pipelines
- Fracture and fatigue assessments in accordance with IGEM TD/1 Edition 6 Supplement 2 (supported by ASME B31.12 and latest CERs)
- Impact of assessments on network operation

Out of Scope

- Detailed assessment of all pipelines and installations (potential future scope)
- All other assessments of pipeline suitability for hydrogen as stated in IGEM TD/1 Edition 6 Supplement 2
- Data generation to support assessments (potential future scope)

Objective(s)

The project objectives are as follows:

1. Calculate, based on high-level assessment, required reductions in pressure or operational parameters (pressure cycles) for hydrogen and hydrogen-natural gas blends for each mainline pipe section
2. Provide recommendations of how to assess impact of low-level blends (<2%, <5%) on network operation
3. Provide recommendations for further work to reduce conservatisms of assessments (enable more optimised network operation)

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

The National Transmission System (NTS) is a key UK infrastructure for the transport of gas to consumers, including those considered vulnerable. In a scenario where hydrogen replaces methane as a household heat source, it is essential the vulnerable are not excluded by virtue of fuel inaccessibility. In cases where vulnerable consumers already utilise gas, it is likely that in a net zero future the optimum option is to provide a consistent energy solution. The transition to hydrogen within the NTS provides continuity of access to the vulnerable of hydrogen as a replacement to methane, with ongoing benefits of efficiency and economy of scale within a closely regulated environment. This project supports the transition of the NTS to hydrogen which in turn supports the availability of gas to the

vulnerable.

An assessment of distributional impacts (technical, financial and wellbeing related) for this project has been carried out using a bespoke assessment tool, which assesses the project as having a positive, negative, or neutral effect on consumers in vulnerable situations. To help inform the assessment, this tool considers the categories of consumers identified in the Priority Services Register. This project has been assessed as having a neutral impact on customers in vulnerable situations. This is because it is a transmission project.

Success Criteria

Success is defined by delivery of project objectives:

· Calculate, based on high-level assessment, required reductions in pressure or operational parameters (pressure cycles) for hydrogen and hydrogen-natural gas blends for each mainline pipe section

· Provide recommendations of how to assess impact of low-level blends (<2%, <5%) on network operation

· Provide recommendations for further work to reduce conservatisms of assessments (enable more optimised network operation)

The following deliverables are envisaged:

WP1: Data Collection and Processing

WP2: Fracture Mechanics Analysis

WP3: Network Modelling

Project Closure

Technical Report

Technical Summary

Closure Report

Project Partners and External Funding

Gas Network – National Gas Transmission PLC

Technical Lead – DNV

Potential for New Learning

The project will generate data on the impact of high-pressure hydrogen on the operation of the National Transmission System (NTS). This data will then be used to inform the safety case submission for 2% blends as well as the wider blending programme within the UK (Project Unite) and the development of the 100% hydrogen backbone (Project Union)

These results might be informative to other transmission networks globally as well as domestic and international gas distribution networks. Where appropriate, results will be disseminated via meetings, committees and conferences.

Scale of Project

This project is a desktop-based study that will provide critical data on the impact of hydrogen in pipeline operation at a network level. Such assessments are needed to remain compliant with current industry codes to ensure safe operation of pipeline systems in hydrogen and hydrogen-natural gas blends.

To mitigate the costs associated with running these assessments it is planned to run high-level screening assessments first to identify

critical pipelines for further, more detailed assessments. Assessment of the entire National Transmission System is required due to the interdependencies between connecting pipelines, meaning that smaller, localised assessments would be unable to fully consider the impacts at the network level.

Technology Readiness at Start

TRL3 Proof of Concept

Technology Readiness at End

TRL4 Bench Scale Research

Geographical Area

United Kingdom

Revenue Allowed for the RIIO Settlement

None – Hydrogen network focused project

Indicative Total NIA Project Expenditure

External – £ 160,000.00

Admin – £ 41,531.33

Internal – £ 11,802.00

Total – £ 213,333.33

Project Eligibility Assessment Part 1

There are slightly differing requirements for RIIO-1 and RIIO-2 NIA projects. This is noted in each case, with the requirement numbers listed for both where they differ (shown as RIIO-2 / RIIO-1).

Requirement 1

Facilitate the energy system transition and/or benefit consumers in vulnerable situations (Please complete sections 3.1.1 and 3.1.2 for RIIO-2 projects only)

Please answer **at least one** of the following:

How the Project has the potential to facilitate the energy system transition:

For the transition to hydrogen, the National Transmission System (NTS) will need to ensure hydrogen can be supplied to consumers reliably and safely. The assessments undertaken in this project will provide a network level view on the permissible operating regime of the NTS. This will inform the roll out of network-level blending (Project Unite) and 100% hydrogen networks (Project Union).

How the Project has potential to benefit consumer in vulnerable situations:

Although this project does not directly affect vulnerable consumers the energy transition may and as such, we must consider the effect of the work we are doing through the NIA funding. The National Transmission System (NTS) is a key UK infrastructure for the transport of gas to consumers, including those considered vulnerable. In a scenario where hydrogen replaces methane as a household heat source, it is essential the vulnerable are not excluded by virtue of fuel inaccessibility. In cases where vulnerable consumers already utilise gas it is likely that in a net zero future the optimum option is to provide a consistent energy solution. The transition to hydrogen within the NTS provides continuity of access to the vulnerable of hydrogen as a replacement to methane, with ongoing benefits of efficiency and economy of scale within a closely regulated environment. Ensuring robust NTS assets and consistent hydrogen production options will support the transition of the NTS to hydrogen which in turn supports the availability of gas to the vulnerable.

Requirement 2 / 2b

Has the potential to deliver net benefits to consumers

Project must have the potential to deliver a Solution that delivers a net benefit to consumers of the Gas Transporter and/or Electricity Transmission or Electricity Distribution licensee, as the context requires. This could include delivering a Solution at a lower cost than the most efficient Method currently in use on the GB Gas Transportation System, the Gas Transporter's and/or Electricity Transmission or Electricity Distribution licensee's network, or wider benefits, such as social or environmental.

Please provide an estimate of the saving if the Problem is solved (RIIO-1 projects only)

N/A

Please provide a calculation of the expected benefits the Solution

This project will provide first pass assessment on the impact of hydrogen and hydrogen-natural gas blends on the operation of the national transmission system (NTS). This will inform the roll out of network-level blending (Project Unite) and 100% hydrogen networks (Project Union), and feed into the 2% blend safety case. Furthermore, the work undertaken in this project will provide justification for future projects/data gathering exercises to enable optimised network operation.

The project value tracking is listed below:

- Maturity

o TRL 4-5. Assessments will use existing approaches.

- Innovation Opportunity

o 100% of single asset class. All pipelines and will be considered.

- Deployment Costs

o £0.00. No direct deployment costs associated with this project.

· Innovation Cost

o £ 200,000.00. As per quotation from supplier plus internal costs.

· Financial Saving

o £ 0.00. Assessment will help establish safe operating regime for NTS pipelines in hydrogen and hydrogen-natural gas blends. No direct cost saving expected.

· Safety

o 0%. Assessment will help establish safe operating regime for NTS pipelines in hydrogen and hydrogen-natural gas blends. Without these assessment NTS pipelines might be at risk of failure due to hydrogen embrittlement.

· Environment

o 0.0 tonnes CO2e. Assessment will help establish safe operating regime for NTS pipelines in hydrogen and hydrogen-natural gas blends. No direct environmental saving expected, although CO2 saving would occur with the addition of H2 to natural gas.

· Compliance

o Ensures compliance. Assessments are required as part of our new TR/10 repurposing process and aligns with requirements of the latest ASME hydrogen pressure code.

· Skills & Competencies

o Individuals. Will develop knowledge of individuals working on the project.

· Future Proof

o Must Have for the business strategy. Assessments are required to enable business strategy of enabling hydrogen blends onto the NTS.

Please provide an estimate of how replicable the Method is across GB

The project will assess the impact of hydrogen on the high-pressure National Transmission System (NTS). The results will be therefore be specific to the NTS, however, the general approach can be adopted by other networks seeking to operate high-pressure hydrogen or hydrogen-natural gas blend pipelines.

Please provide an outline of the costs of rolling out the Method across GB.

High-level assessments will be undertaken for the entire NTS. The outcomes of these assessments will inform the level and extent of more detailed assessments that might be required across Great Britain. At present it is not possible to outline the associated costs as the impact this project will have on the required assessments cannot be known until after the project.

Requirement 3 / 1

Involve Research, Development or Demonstration

A RIIO-1 NIA Project must have the potential to have a Direct Impact on a Network Licensee's network or the operations of the System Operator and involve the Research, Development, or Demonstration of at least one of the following (please tick which applies):

☐ A specific piece of new (i.e. unproven in GB, or where a method has been trialled outside GB the Network Licensee must justify repeating it as part of a project) equipment (including control and communications system software).

☐ A specific novel arrangement or application of existing licensee equipment (including control and/or communications systems and/or software)

☐ A specific novel operational practice directly related to the operation of the Network Licensees system

☐ A specific novel commercial arrangement

RIIO-2 Projects

☐ A specific piece of new equipment (including monitoring, control and communications systems and software)

☐ A specific piece of new technology (including analysis and modelling systems or software), in relation to which the Method is unproven

☑ A new methodology (including the identification of specific new procedures or techniques used to identify, select, process, and analyse information)

☐ A specific novel arrangement or application of existing gas transportation, electricity transmission or electricity distribution equipment, technology or methodology

☐ A specific novel operational practice directly related to the operation of the GB Gas Transportation System, electricity transmission or electricity distribution

☐ A specific novel commercial arrangement

Specific Requirements 4 / 2a

Please explain how the learning that will be generated could be used by the relevant Network Licensees

The research and analysis undertaken in this project will be applicable to pipeline operators and will inform the strategy for pipeline/asset repurposing for the energy transition.

Or, please describe what specific challenge identified in the Network Licensee's innovation strategy that is being addressed by the project (RIIO-1 only)

N/A

Is the default IPR position being applied?

☑ Yes

Project Eligibility Assessment Part 2

Not lead to unnecessary duplication

A Project must not lead to unnecessary duplication of any other Project, including but not limited to IFI, LCNF, NIA, NIC or SIF projects already registered, being carried out or completed.

Please demonstrate below that no unnecessary duplication will occur as a result of the Project.

There will be no duplication of activities done as part of this programme. There is work undertaken, globally, on hydrogen impacts on pipelines, however, none of this research has been undertaken on the National Transmission System of Great Britain.

If applicable, justify why you are undertaking a Project similar to those being carried out by any other Network Licensees.

N/A

Additional Governance And Document Upload

Please identify why the project is innovative and has not been tried before

Assessments of the impact of hydrogen and hydrogen-natural gas blends on National Transmission System pipelines have never been undertaken at the network level before.

Relevant Foreground IPR

This project and the resultant outcomes/deliverables will conform to the default treatment of IPR as set out under the agreed NIA Governance (where the default requirements address two types of IPR: Background IPR and Foreground IPR).

The results of the project are not expected to generate any foreground IPR, as the proposed approaches conform to industry practices.

Data Access Details

Data for this project, and all other projects funded under the Network Innovation Allowance (NIA) funding scheme, can be found, or requested in a number of ways:

· A request for information (RFI) via the Smarter Networks Portal at https://smarter.energynetworks.org. National Gas Transmission regularly publishes much of the data arising from our innovation projects on the ENA portal, before submitting a RFI check this website.

· Via our managed mailbox box.GT.Innovation@nationalgas.com. Further data can be shared upon request through the innovation mailbox. Each request will be assessed by the NGT Innovation Team for its merits and viability.

Please identify why the Network Licensees will not fund the project as apart of it's business and usual activities

This project is focussed on the impact of high-pressure hydrogen gas on metallic network components, as the existing network does not carry hydrogen gas this work cannot be considered business as usual. It is therefore relevant for NIA funding.

Please identify why the project can only be undertaken with the support of the NIA, including reference to the specific risks(e.g. commercial, technical, operational or regulatory) associated with the project

This approach is unknown and there are many routes that could be taken, there is a risk that without this work the different energy networks would spend time and money on carrying out the research and testing. The NIA funding reduces this risk and enables the feasibility of repurposing existing assets to be assessed.

This project has been approved by a senior member of staff

☑ Yes